Rutgers University Graduate School – New Brunswick
Course Proposal Form

Graduate Program and Number: **Biomedical Engineering 16:125**

Course Number and Title: **16:125:578 "INTERDISCIPLINARY BIOSTATISTICS RESEARCH TRAINING FOR MOLECULAR AND CELLULAR SCIENCES: ENHANCING RIGOR AND REPRODUCIBILITY"**

Credits: **3** Class Hours: Lecture/Seminar **1/week**
Laboratory **NO**
Other (specify)

Term normally to be offered: **Spring** To be offered first in: **Spring 2017**

Prerequisites: **Undergraduate degree in BME or other related field.**

Expected Enrollment: **30-40 students**

Instructor(s): **Professors Ramsey Foty, PhD and Martin Yarmush, MD PhD**

Status on Graduate Faculty (Member, Associate Member or Nominee?) **Both are Members**

1. Relationship of the new course to the graduate program curriculum

This course will be offered as a Graduate Program Elective in BME and will be open to graduate students with standing in BME, CBE, or other related fields (i.e. biology or engineering). This course will also be a requirement for graduate students accepted into the NIH Biotechnology Training Program. The development of this course was enabled by a grant from the NIH.

2. Relationship of the new course to courses offered by other graduate programs or undergraduate depts

There are no other similar courses in the BME graduate program. This course is differentiated from all existing statistics courses at Rutgers in that its focus is on experimental results obtained in the molecular and cellular sciences exclusively.

3. Brief description of course for publication in the catalog of the Graduate School – New Brunswick (30 words)

This course will provide both life science and engineering students with a strong foundation in statistical approaches to data analysis and will be specifically tailored to the molecular, cellular, and tissue biotechnology and bioengineering data relevant to their thesis projects. Two particularly important components of the course involve the training of students on how to: 1) critically assess and interpret published scientific data, and 2) enhance and optimize experimental rigor and reproducibility. An active learning strategy combining didactic instruction and experiential training will reinforce understanding and appreciation for the importance of data analysis in designing rigorous and reproducible data suitable for publication in top-tier scientific journals. This course will be taught by bench scientists with a solid grasp of statistical methodology, using easy to understand terminology, and who are very effective teachers of statistics to wide audiences. The development of this course was enabled by a grant from the NIH; this course will become the quantitative science requirement for all Biotech program fellows.

4. Spring 2017 Syllabus

Week	Topic	Reading
1	**Overview and Descriptive Statistics.** Type of data, graphic presentation, central tendency and dispersion, introduction to R, introduction to GraphPad Prism.	Ch. 1, 2
2	**The Tooth and Tendon Lab.** Students will generate data of tooth and tendon dimensions and weight to demonstrate variability within and between groups. They will use GraphPad Prism to present their data.	
3	**Probability and Distributions.** Probability, conditional probability, binomial and normal distribution.	Ch. 3, 4
4	**Estimation.** Sampling distribution, confidence interval (population means and proportions), sample size estimation based on proportions.	Ch. 5, 6
5	**Hypothesis Testing**. Type I and type II error, steps of performing hypothesis testing (on population means, on population proportions, *z* and *t*-statistics), power and sample size estimation.	Ch. 7
6	**The Sickle Cell Lab.** Students will be asked to measure the length and width of sickle cells as a function of oxygen concentration and determine if there is statistical difference between the two groups.	
7	**Analysis of Variance.** Comparisons between and among means, multiple comparisons.	Ch. 8
8	**Correlation and Regression.** Correlation and simple linear regression.	Ch. 9
9	**Multiple Linear Regression and Logistic Regression.** Multiple linear regression, model building and diagnosis, logistic regression.	Ch. 10,11
10	**Analyze my Data Lab.** Students will analyze data that they have generated using R and GraphPad Prism to analyze and graphically display the results.	
11	**Nonparametric Statistics.** Sign test, Wilcoxon sign rank test, Wilcoxon rank sum test, Kruskal-Wallis test.	Ch. 13
12	**Survival Analysis**. Kaplan-Meier procedure, Log-rank test, Cox proportional hazard model.	Ch. 12
13	**Biostatistics in the Genomic Age.** Microarray data analysis.	
14	**Reading the Scientific Literature.** Use and misuse of statistical analysis in the scientific literature	Handouts
15	**Rigor and Reproducibility.** The absolute importance of unbiased experimental design, methodology, analysis, interpretation, and reporting of results that can be reproduced by multiple scientists.	Handouts
16	**Student Presentations.** Students will hand in and present preliminary statistical design and data analysis plan for their thesis projects.	

Textbooks: *Biostatistics: A Foundation for Analysis in the Health Sciences*, 9'th Edition (2008) by Wayne W. Daniel. *Intuitive Biostatistics* (1995) by Harvey Motulsky.

Software: *R: A Language and Environment for Statistical Computing* (available from http://www.r-project.org)
GraphPad Prism 6. Commercially available 2D graphing and statistics software package published by GraphPad Software, Inc. Licenses can be purchased for an annual cost of $100/license. The user guide can be accessed online at http://www.graphpad.com/guides/prism/6/user-guide/. The textbook by Motulsky is an excellent companion to the software.

Criteria for student grading:
20% Class Participation
30% Homework Assignments
30% Participation in Group Projects
20% Presentation of Statistical Analysis Plan

5. Statement of course objectives and how learning outcomes will be assessed

After successfully completing this course, the student should be able to:

1. Have a good understanding of how to: 1) critically assess and interpret published scientific data, and 2) enhance and optimize experimental rigor and reproducibility.
2. Learn about new and upcoming statistical techniques and packages that will be helpful in designing and analyzing experiments in their thesis research

These learning objectives are accomplished and assessed via the 4 components detailed above under "Criteria for student grading":

1. ***Class Participation:*** Participation will be graded by both attendance and in-class activity. Students are encouraged to ask questions and respond to the instructors.
2. ***Homework:*** Homework assignments will require critical thinking in the context of lecture material and the assigned reading.
3. ***Participation in Group Projects:*** Student will also be placed into groups for in-class activities which will encourage team work. The groups will present their findings to the class and rotation of lead speakers is required.
4. ***Presentation of Statistical Analysis Plan:*** Students will hand in and present preliminary statistical design and data analysis plan for their thesis projects. The presentation will allow the students to demonstrate their speaking and presentation skills, and will provide the students a chance to teach the class something new.

6. Instructions in the syllabus informing students of the academic integrity policy and aspects in the class

Academic Integrity:
Students are expected to familiarize themselves with and adhere to the University policy on academic integrity at: http://academicintegrity.rutgers.edu/policy-on-academic-integrity.

Approval of the Graduate Director: Date:

Approval of the Professional School Dean: Date:

One copy of this signed form with attachments for items 1-4 above, together with a copy of the Registrar's Form 29 for **each** course number, should be forwarded to the Office of the Graduate School – New Brunswick for review by the Area Committee and the Executive Council. It should be submitted one semester before the deadline for course scheduling.